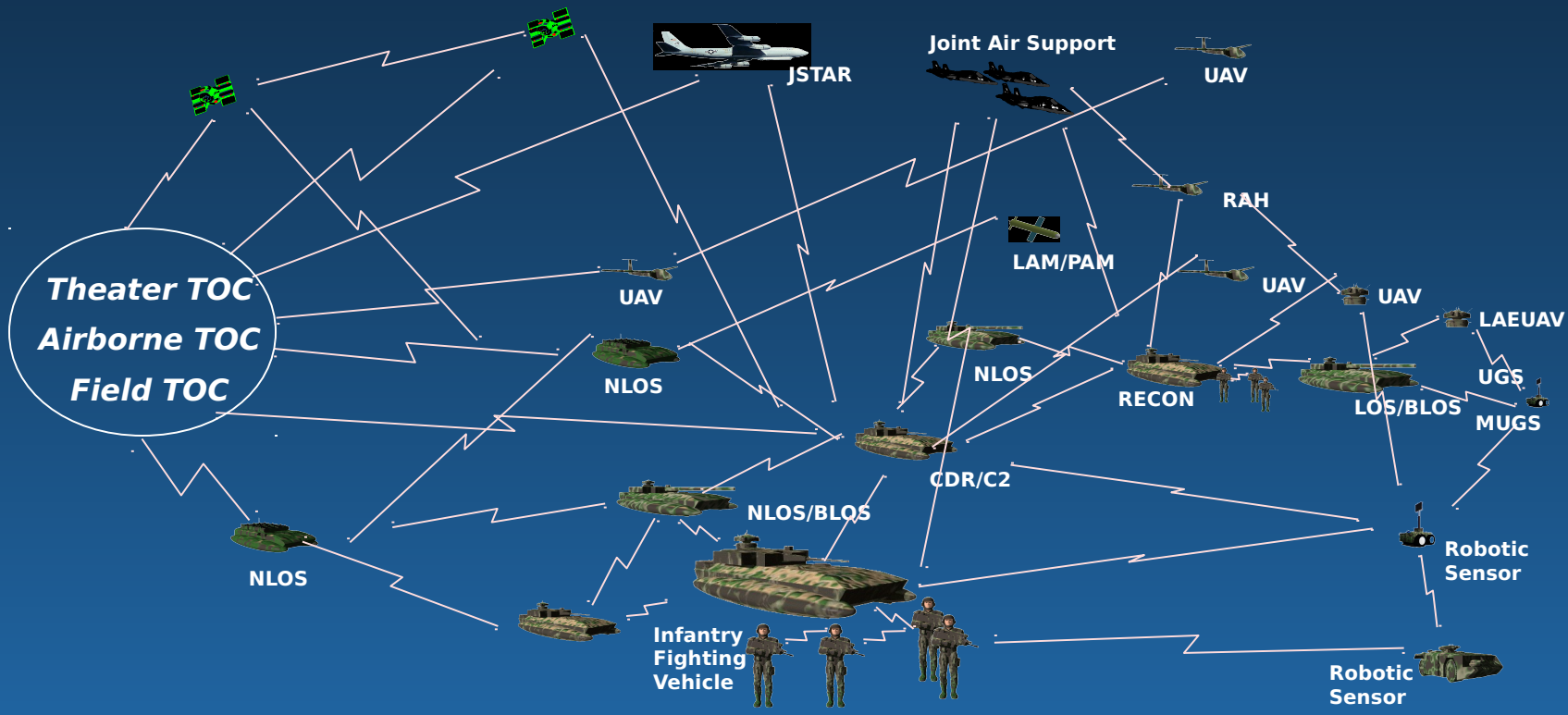
Network Centric Warfare - Digital Battlefield Data Collection & Analysis



Challenges in Evaluating the NCW Digital Battlef

Evolution of the Digital Battlefield

- **In the early 1990's with the emergence of the "Digital Battlefield", information dissemination on the battle field went through a fundamental shift from voice to digital transmission.**
  - ***PC's on tactical vehicles and installations used to create, process and distribute large volumes of data used to manage force functions.***
  - ***Testing methods had to change.***
  - ***Previously Subject Matter Experts (SME's) collected data manually***
  - ***Data manually collated to create final reports.***
  - ***Limited Real-time feedback***

Evolution of the Digital Battlefield (Cont)

- **Testing the “Digital Battlefield” required development of new instrumentation, data collection methods and processing of the collected data.**
- **Determining the performance of these new systems required collection of “orders of magnitude” larger data sets.**
- **Post exercise processing of large amounts of data**
- **The proliferation of digital resources formed architecture allowing Platform Centric Warfare**

Data Collection – Evolution of the Digital Battlefield

1994 Inter Vehicular Information System (IVIS)

- *NTC 94-07 Desert Hammer*
- *20 M1 Abrams*
- *2 channels SINCGARS @ 1200 & 2400 baud*

1995 Brigade and Below Command and Control (B2C2)

- *Warrior Focus, 10th Mountain Fort Drum & JRTC*
- *20 systems including M1's M2's, & Dismounts*
- *2 Channels, SINCGARS @ 2400, 9600, & 16Kbps*

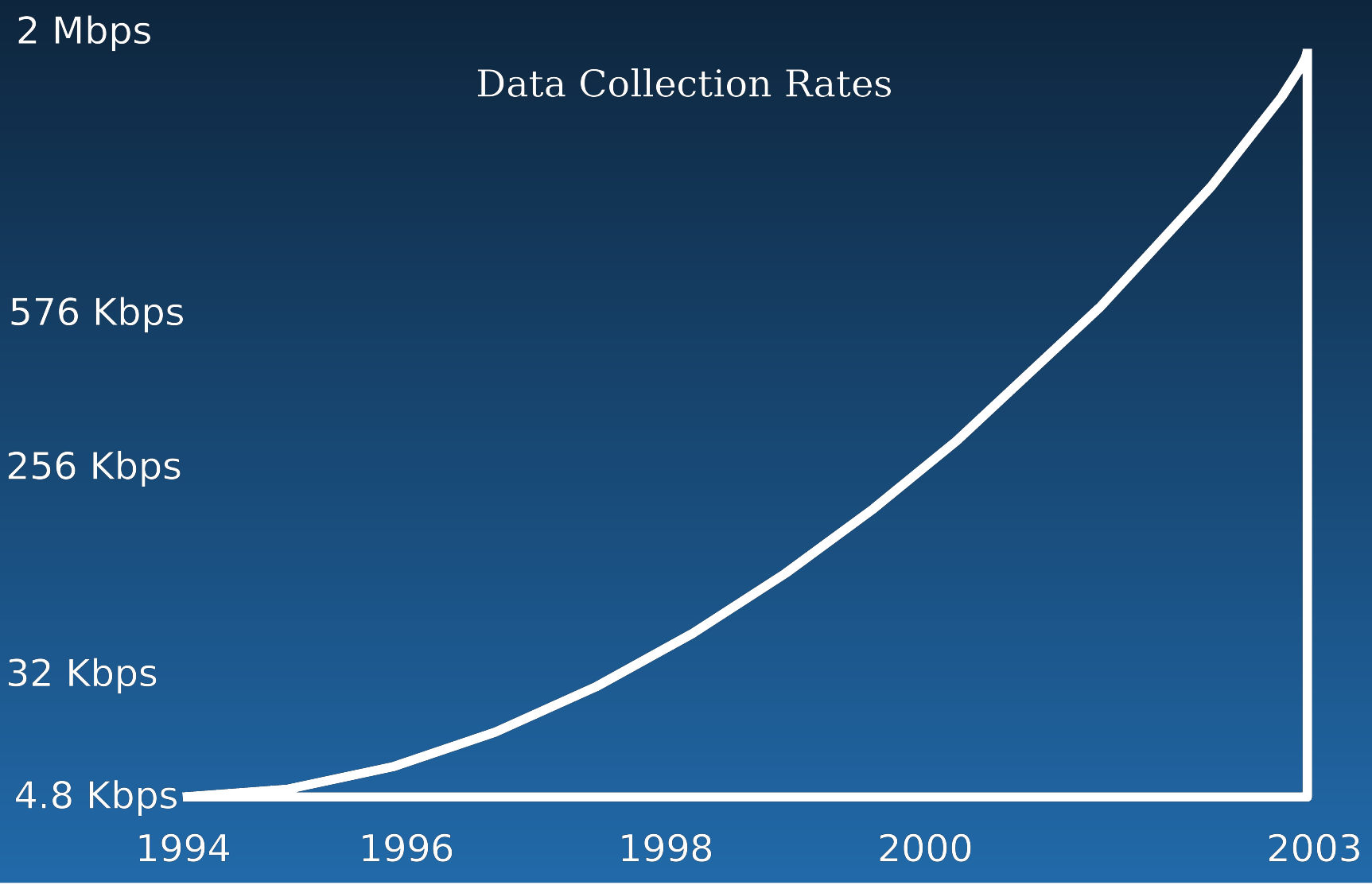
1997 Appliqué

- *Task Force XXI*
- *60 units (WPNS)*
- *4 Channels, EPLRS, 2 SINCGARS, Inter-Net Controllers (INC)*

2000 - 2003 Force Brigade Battalion and Below (FBCB2)

- *FBCB2 4th Infantry Division*
- *> 200 units Higher Data Rates and Jamming*
- *4 Channels, EPLRS, 2 SINCGARS, Inter-Net Controllers (INC), NTDR*

Data Collection – Putting it in Perspective



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Radios in the Battle Environment

- **SINCGARS** > 30-88 MHZ - 16 KBPS digital voice, data 75 BPS & 16 KBPS
- **Have Quick II** (UHFAM/FM/PSK) > 225-400 MHZ - Analog & 16 KBPS digital voice, data 75 BPS to 16 KBPS
- **EPLRS** > 420-450 MHZ. Data mode 57 KBPS VHSIC SIP and 228 KBPS VECP
- **Wideband Networking Waveform** > Expected 2 MHZ to 2 GHZ up to 5 MBPS networked throughput
- **LINK 16** > 960 to 1215 MHZ. - voice 2.4 and 16 KBPS, data 28.8 KBPS to 1.137 MBPS
- **LINK 11/TADIL** > 2-30 MHZ and 225-400 MHZ - data 1364 and 2250 BPS. VHF FM - - 30-88 MHZ - analog and digital voice at 16 KBPS
- **VHF ATC Data Link** > 2-30 MHZ. – analog, voice & data at 300, 600, 1200 & 1800 BPS
- **VHF/UHF FM LMR** > 136-174 MHZ, 380-512MHZ, and 764-869 MHZ analog & digital voice at 16 KBPS

Radios in the Battle Environment (Cont)

- **Soldier Radio and WLAN** > 1.755-1.850 GHZ. - digital 16 KBPS voice, data at 1 MBPS.
- **MUOS** > 240-320 MHZ - data at 2.4, 9.6, 16, 32 and 64 KBPS.
- **Cellular Radio** > 824-894 MHZ, 890-960 MHZ and 1850-1990 MHZ - voice and data at 10 KBPS nominal, 3G rates up to 144/384 KBPS and 2 MBPS.
- **Mobile Satellite Service (MSS)** > 1.61-2 GHZ - digital voice at 2.4 to 9.6 KBPS.
- **Integrated Broadcast Service-Module (IBS-M)** > 225-400 MHZ - data at 2.4, 4.8, 9.6 and 19.2 KBPS.
- **VHF ATC Data Link (NEXCOM)** > 118-137 MHZ - digital voice at 4.8 KBPS, data at 31.5 KBPS.
- **UHF AM/FM PSK** > 225-400MHZ and 225-450 MHZ – analog, digital voice and data rates up to 16 KBPS.
- **Link 4A** > 225-400 MHZ. - data at 5 KBPS.
- **Link 11B** > 225-400 MHZ - data at 600, 1200, and 2400 BPS.
- **DWTS** > 1350-1850 MHZ – analog, digital voice and data at rates of 144, 256, 288, 512, 576, 1024, 1152, 1544, 2048 and 2304 KBPS.

Evolution of Information Technology

- **Information technology is undergoing a fundamental shift from platform-centric computing to network-centric computing.**
  - ***Platform-centric computing emerged with widespread proliferation of PC's***
  - ***IT sector investments in research, and product development led to key technologies creating conditions for emergence of network-centric computing.***
- **Primary Example - explosive growth of internet, intranets, and extranets.**
  - ***Transmission control protocol/internet protocol (TCP/IP), hypertext transfer protocol (HTTP), hypertext markup language (HTML), Web browsers, search engines, and JavaTM Computing are network basics.***

Evolution of Information Technology (Cont)

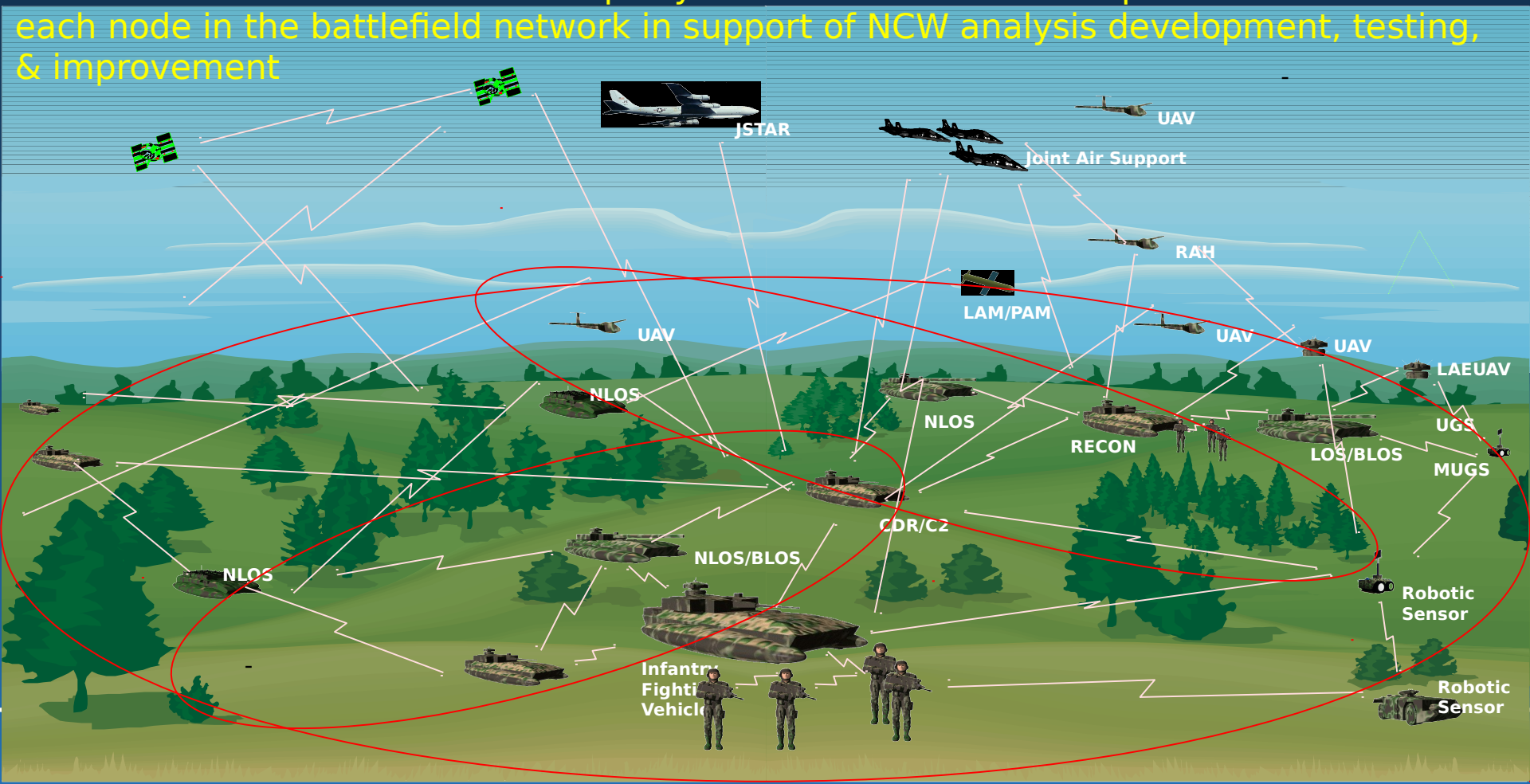
- **These technologies, combined with high-volume, high-speed data access (enabled by the low-cost laser) and technologies for high-speed data networking (hubs and routers) led to emergence of network-centric computing.**

  - ***Information "content" now can be created, distributed, and easily exploited across the extremely heterogeneous global computing environment.***

Network Centric Warfare- Digital Battlefield Instrumentation

NCW is a Highly Orchestrated Dynamic Autonomous Digital Battlefield Communications Command, Control, and Situational Awareness Network

- Technically NCW will present unseen communications and analysis challenges and complexities.
- NCW Instrumentation must be equally as robust to allow the capture of the data at each node in the battlefield network in support of NCW analysis development, testing, & improvement



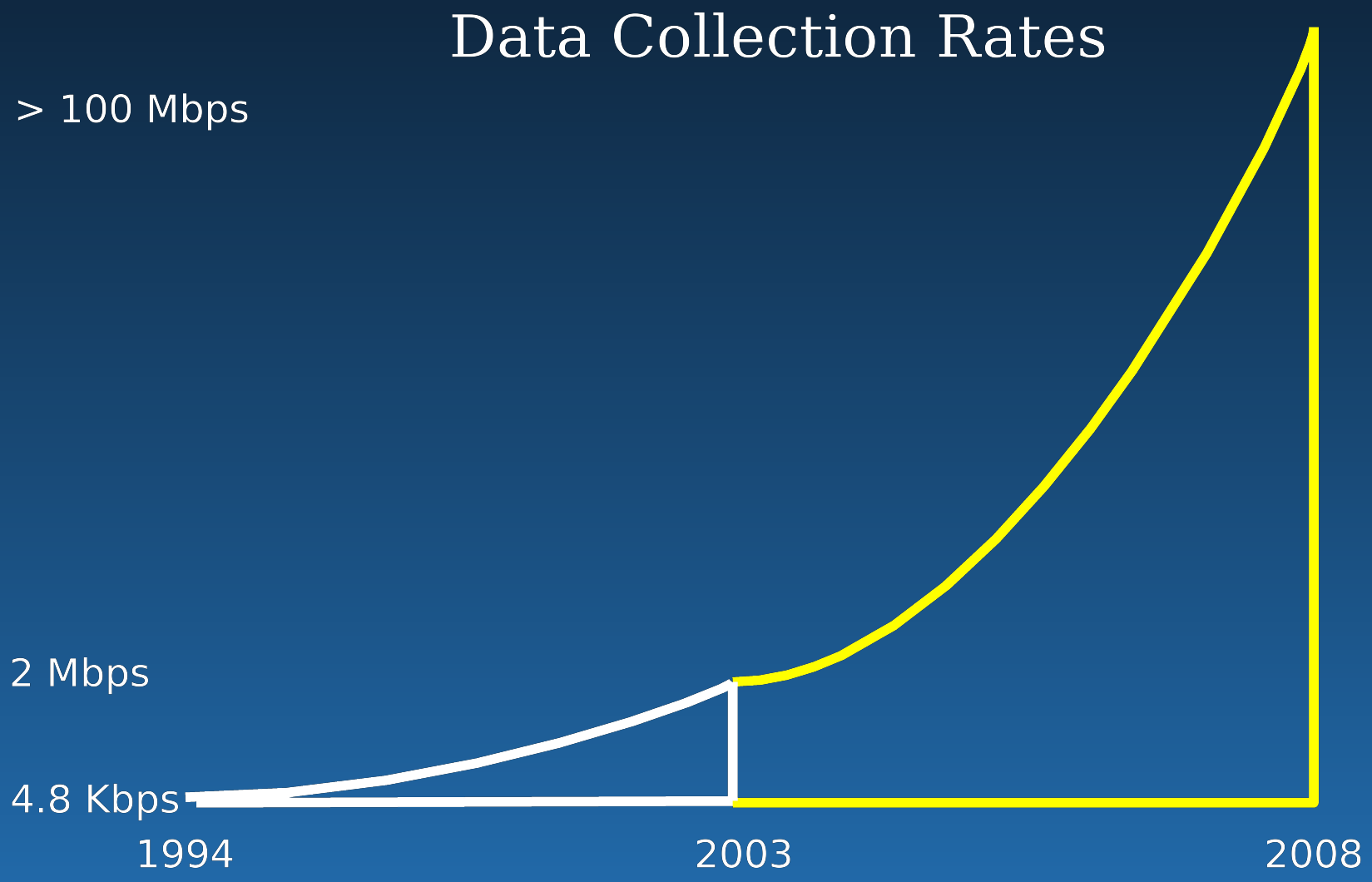
NCW Radios Resources - Examples

- High Band JTRS: Rockwell Collins working with DARPA on high band JTRS concept, integrated within the low band terminal, provides high data rates required for network centric warfare.
- The high band demo conducted at Lakehurst Naval Air Station Sept. 2002 average node throughput 25 Mbps.
- A TRL-5+ demo at Idaho National Guard training facility average node throughput > than 75 Mbps.
- Previous communications architectures supported low bandwidths, typical tactical communications nodes below 64 Kbps, backbone channels 2 Mbps or less.
- Multimedia and video teleconferencing requires sustained rates > 500 Kbps and backbone rates > 40 Mbps.
- MANET Architectures utilizing 802.11b 11 Mbs, 802.11a 54 Mbs are a reality

NCW Data Collection Issues

- **No Integrated capability exists to support Collective Realistic Testing, Experimentation & Analysis of NCW in a combined asset Force-on-Force environment.**
- **NCW Data Collection and Analysis Requirements:**
  - **Test , Evaluate, and Mature NCW communication systems**
  - **Obtain 100% full Situational Awareness of all Digital Battlefield Communications to and from all Network Nodes -100% Ground Truth!**
  - **Evaluate the Combined Arms Casualty Impact of NCW in a Realistic Battlefield Environment**
  - **Stimulate the effects of Threat Jamming and BLUEFOR - NATO Battlefield Emissions at each NCW node**
  - **Support the entire Life Cycle of NCW from Lab Development to Fielded Systems Upgrades**

Data Collection – Putting it in Perspective



NCW Data Collection – More Data or More Information?

- Data Collection Points ?
  - How many nodes need to be monitored to have a large enough sample of the data?
  - Where do you monitor -TOC, Relays, Weapons (Radio, INC, LAN), UAV's ?
  - How do you monitor Joint Assets?
- Data Reduction requirements ?
  - Throughput
  - Message Completion Rate
  - Distributed Processing
- Data elements measured in Giga, possibly Terra bites

NCW Data Collection – Embedded Instrumentation

- Use System Under Test (SUT) resources to collect and pre-process data
- Use Tactical Networks to send data back to Data Reduction Station and for Real-Time feedback
- Instrumentation Appliques' where required
- Provides ability to collect data from all test participants

NCW Data Collection – Embedded Instrumentation

Question – If all embedded instrumentation is developed as part of the SUT, what Instrumentation is going to be used to determine if the data collected is valid?